ZOOLOGICAL SCIENCE 5: 165–178 (1988)

Land Hermit Crabs from the Ryukyus, Japan, with a Description of a New Species from the Philippines (Crustacea, Decapoda, Coenobitidae)

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ABSTRACT—Six species of land hermit crabs are now known from Japan. Of them *Coenobita brevimanus* and *C. violascens* are recorded from Japan for the first time. *C. purpureus* and *C. violascens* hitherto synonymized with *C. perlatus* and *C. cavipes*, respectively, are valid. These species are redescribed and discussed in more detail. *C. pseudorugosus* is described and illustrated as a new species on the basis of the specimens from the Philippines.

INTRODUCTION

In the Indo-West Pacific region, the genus *Coenobita* is represented by ten valid species [1–6]: *C. rugosus* H. Milne Edwards, 1837; *C. purpureus* Stimpson, 1858; *C. perlatus* H. Milne Edwards, 1837; *C. cavipes* Stimpson, 1858; *C. violascens* Heller, 1862; *C. brevimanus* Dana, 1852; *C. scaevola* (Forskål, 1775); *C. spinosus* H. Milne Edwards, 1837; *C. carnescens* Dana, 1852; *C. longitarsis* De Man, 1902. Among these species, *C. purpureus* and *C. violascens* have hitherto been treated as the synonym of *C. perlatus* and *C. cavipes*, respectively. In our recent study, however, comparison of the specimens from the Ryukyus reveals that they are valid species; Miyake [7] had already separated *C. purpureus* from *C. perlatus*.

The specimens from the Ryukyus were collected from the Miyako and the Yaeyama Islands during the ecological and distributional studies of land hermit crabs in Okinawa Prefecture, except *C. perlatus*, although this species has also been reported from Kuroshima, the Yaeyama Islands by Miyake [7].

The specimens collected from Cebu I., the Philippines were also examined and revealed to belong to an undescribed species of the genus *Coenobita*. However, this species has been not reported from the Ryukyus.

The objectives of the present paper are to provide information on land hermit crab species in Japan, and to resurrect the synonym of some species, as well as to describe a new species of *Coenobita*.

Accepted August 19, 1987
Received June 12, 1987

Coenobita pseudorugosus n. sp.
(Figs. 1A–H and 2)

Material examined: Holotype, male (SL=Shield Length, 12.37 mm). Paratypes, 15 males (SL= 7.29–12.13 mm), 22 non-ovigerous females (SL= 5.63–10.75 mm), Cebu I., the Philippines, Apr. 30, 1986, T. Higa leg.

Diagnosis: Rostrum small and triangular. Ocular acicle broad basally, triangular and terminating in a small spine. Antennular basal segment with very produced laminar portion proximally and vertical margin of its lamina making an obtuse angle with upper margin of segment. Palm of left cheliped with an oblique series of seven to ten up-standing laminar teeth on upper part of outer surface; lower margin of propodus nearly straight in distal half and not four-cornered in an external form. Outer surfaces of dactylus and propodus of left third leg flat, smooth and separated from dorsal surface by a well-marked longitudinal crest. Right coxa of fifth legs in male produced into an

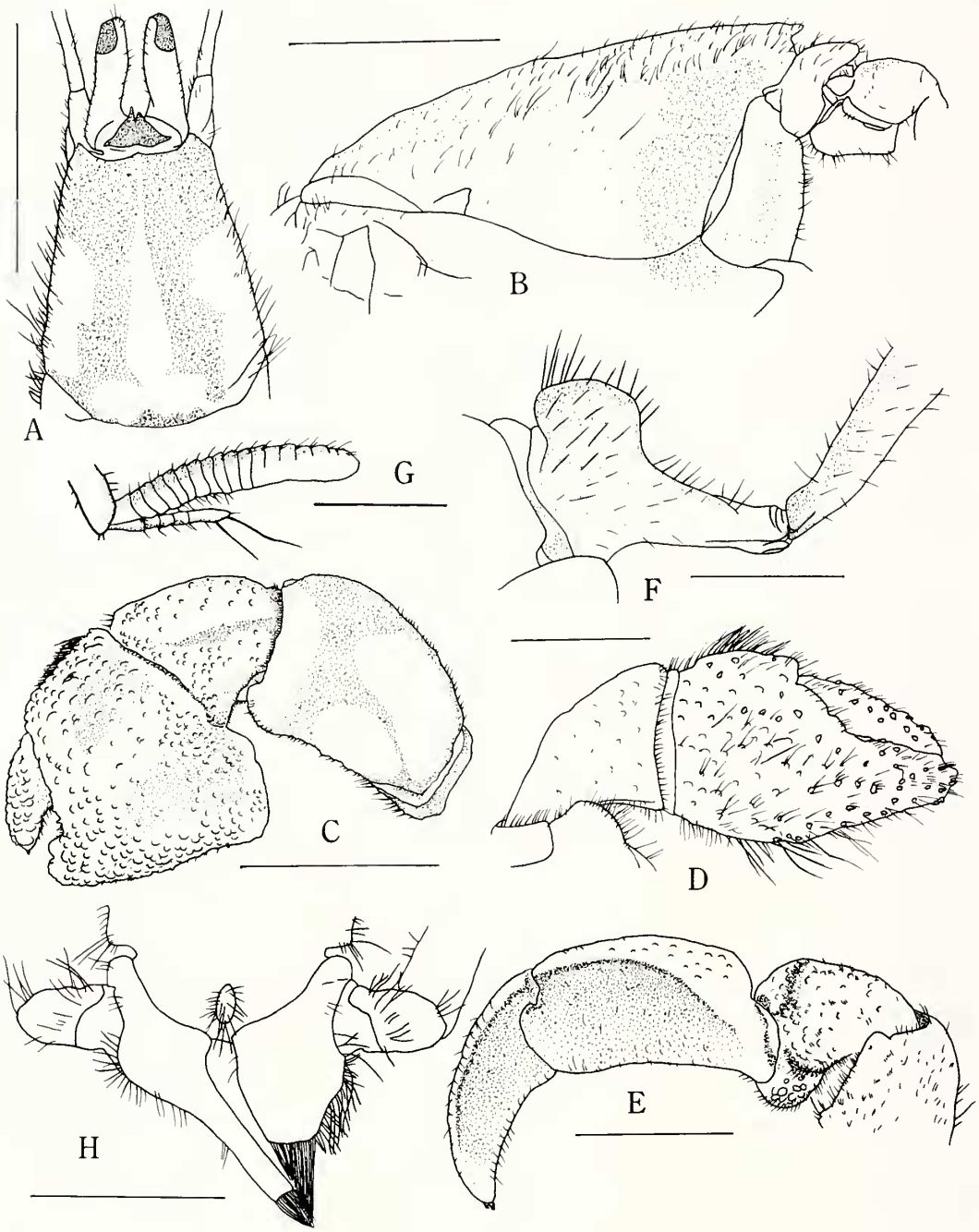

FIG. 1. *Coenobita pseudorugosus* n. sp., male, paratype (SL=11.3 mm). A, shield and some cephalic appendages, dorsal view; B, shield and antennal segments, lateral view; C, left cheliped; D, chela and carpus of right cheliped; E, left third leg, lateral view; F, basal segment of antennule; G, flagella of antenna; H, sternite and coxae of male fifth legs. Scale bars indicate 10 mm for A, C, E, 5 mm for B, D, H, and 2.5 mm for F and G.

elongate tube, always longer than left one.

Description: Shield usually longer than broad, narrower anteriorly; anterior margin between rostrum and lateral projections concave; rostrum small and triangular; dorsal surface with scattered granules on anterior and lateral portions; and lateral margins setose.

Ocular acicle broad basally, triangular and terminating in a small spine. Ocular peduncle compressed, reaching nearly to two-thirds the length of ultimate segment of antennal peduncle.

Antennular basal segment with very produced laminar portion proximally and vertical margin of its lamina making an obtuse angle with upper margin of segment; small flagellum of antennule reaching nearly to one-half length of large one. Antennal acicle fused with second segment of its peduncle.

In left chelipeds (Fig. 2) palm with an oblique series of seven to ten up-standing laminar teeth on upper part of outer surface; lower margin of propodus nearly straight in distal half and not four-cornered in an external form; palm with scattered round granules in addition to oblique teeth on outer surface, numerous especially on its lower portions; both fingers also with numerous round granules on outer surfaces; inner surface of palm strongly elevated in middle part and covered with large scale-like tubercles; movable finger with corneous-tipped granules on inner surface. In small cheliped fingers and palm with corneous-tipped granules and setae on outer surfaces.

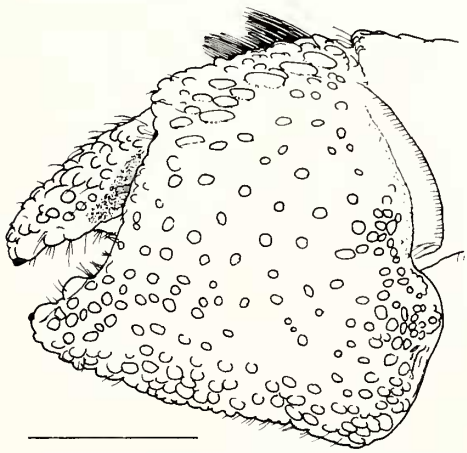

FIG. 2. *Coenobita pesudorugosus* n. sp., male, paratype (SL=11.3 mm). Enlargement of chela of the same cheliped as Fig. 1C. Scale 5 mm.

In left third leg (Fig. 1E) outer surfaces of dactylus and propodus flat, smooth and separated from dorsal surface by a well-marked longitudinal crest; walking legs except left third leg with setae on lower margin of each segment. In male coxae of fifth legs of both sides produced ventrally, unequal, and right coxa produced into an elongate tube, always longer than left one; its tube turning to the left and curved ventrally.

Coloration: Small individuals with a broad dark brown transverse band at anterior one-third of shield and two longitudinal stripes of the same color on posterior portion. Large individuals sometimes with two dark brown patches behind anterior margin of shield. Side walls of shield with a dark brown transverse band on anterior part. Ventral surface of ocular peduncle dark brown. Palm of left cheliped with a longitudinal white stripe on middle portion and the other part dark-brownish. Dactyli of left second and third legs each with a dark brown patch at proximal part. Propodus of left third leg with a broad dark brown band on middle portion; propodi of other legs with a white band at distal one-fourth, other area dark-brownish. Carpi of first and third legs with a longitudinal dark brown stripe; meri with dark brown ring distally.

Distribution: Known only from the type locality.

Remarks: *C. pseudorugosus* is most closely related to *C. rugosus*, but is distinguishable from the latter by the following characters. In *C. pseudorugosus* the lower margin of the propodus of the large cheliped is nearly straight for the distal half and the palm is, therefore, not four-cornered in an external form, while the palm of *rugosus* has an obtuse corner and is thus four-cornered in an external form; the palm of the present species is dark-brownish, lacking a distinct large patch of dark brown on the outer surface, but that of *rugosus* has a distinct large patch of dark brown. In all the specimens of the male, the right sexual tube is distinctly longer than the left one, while in a great number of the specimens of *rugosus* examined, the right sexual tube is almost equal in length to the left, or the right is slightly longer than the left.

Coenobita rugosus H. Milne Edwards (Figs. 3A–G and 9A)

Coenobita rugosa H. Milne Edwards [2], p. 241.
Coenobita rugosus: Alcock [9], p. 143, pl. 14, fig. 3, 3a; Ball and Haig [15], p. 89; Miyake [7], p. 115, pl. 39, fig. 1; Yu [12], p. 61, pl. 1, fig. D.

Material examined: I have treated a large number of individuals during the ecological and distributional studies of the species in Okinawa Prefecture.

Distribution: Widely distributed in the Indo-West Pacific region. In Japan this species is recorded from Chichijima and Anijima Islands in

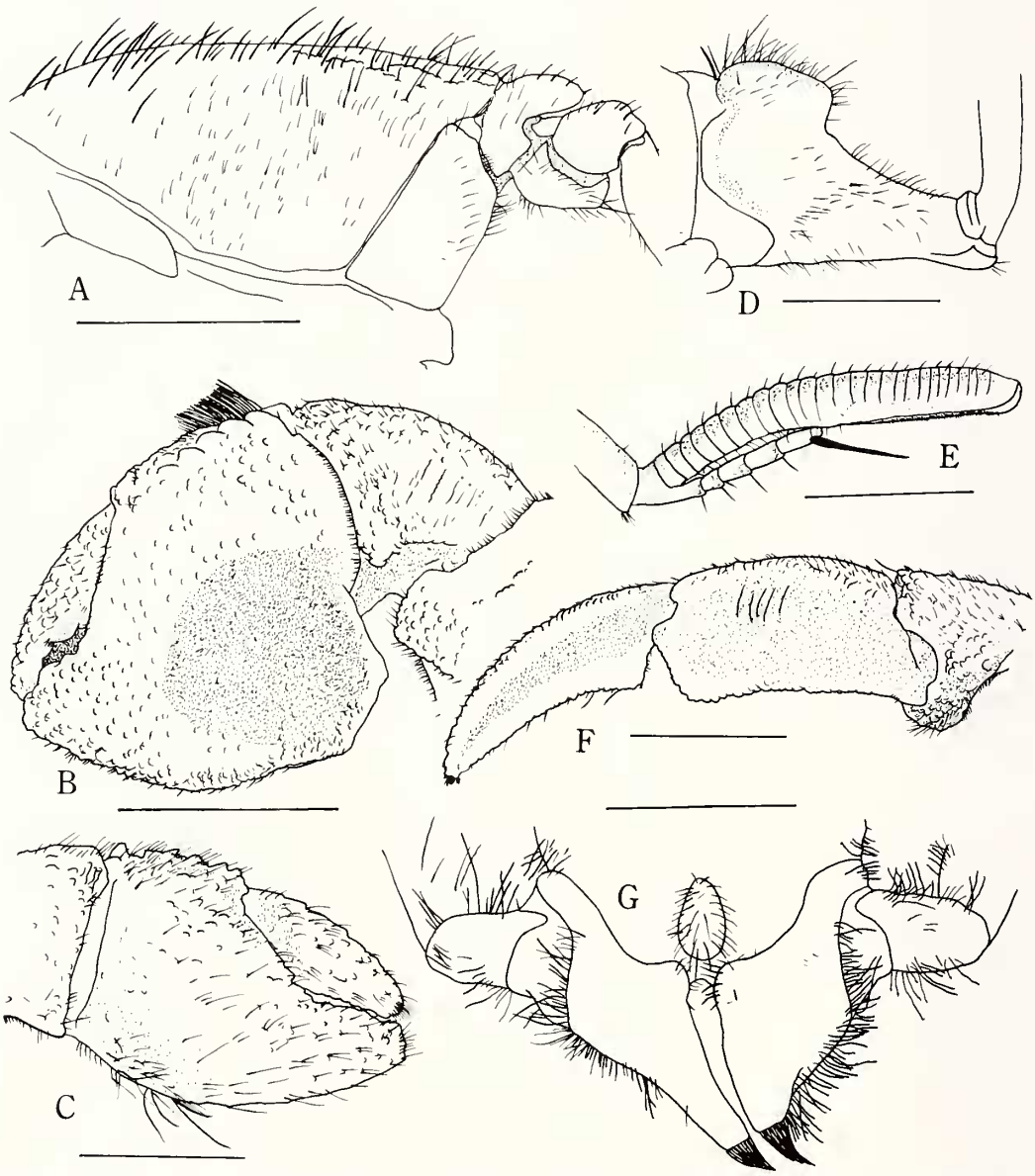

FIG. 3. *Coenobita rugosus* H. Milne Edwards, male. A, shield and antennal segments, lateral view; B, chela and carpus of left cheliped; C, chela of right cheliped; D, basal segment of antennule; E, flagella of antenna; F, left third leg; G, sternite and coxae of male fifth legs. Scales 10 mm for B and F, 5 mm for A, C and G, 3 mm for D, 2.5 mm for E.

the Bonin Islands [19], Amami-Ohshima, Okinoerabujima and Yoronjima Islands in the Amami Islands [20] and from each island of Okinawa Prefecture except Kitadaitojima Island [17, 18, 21].

Remarks: This species is very abundant in Okinawa Prefecture. A great number of individuals are transported from Okinawa to Japan mainland as "pets" together with *C. purpureus* and *C. cavipes*. It is known that the transportation have been started since 1934 [22].

Coenobita purpureus Stimpson
(Figs. 4A–F and 9B)

Coenobita purpurea Stimpson [4], p. 83; Stimpson [23], p. 198.
Coenobita perlata var. *purpurea*: Bouvier [24], pp. 148–150.
Coenobita purpureus: Miyake [7], p. 221.

Material examined: I have examined a large number of individuals during the ecological and distributional studies of this species in Okinawa Island.

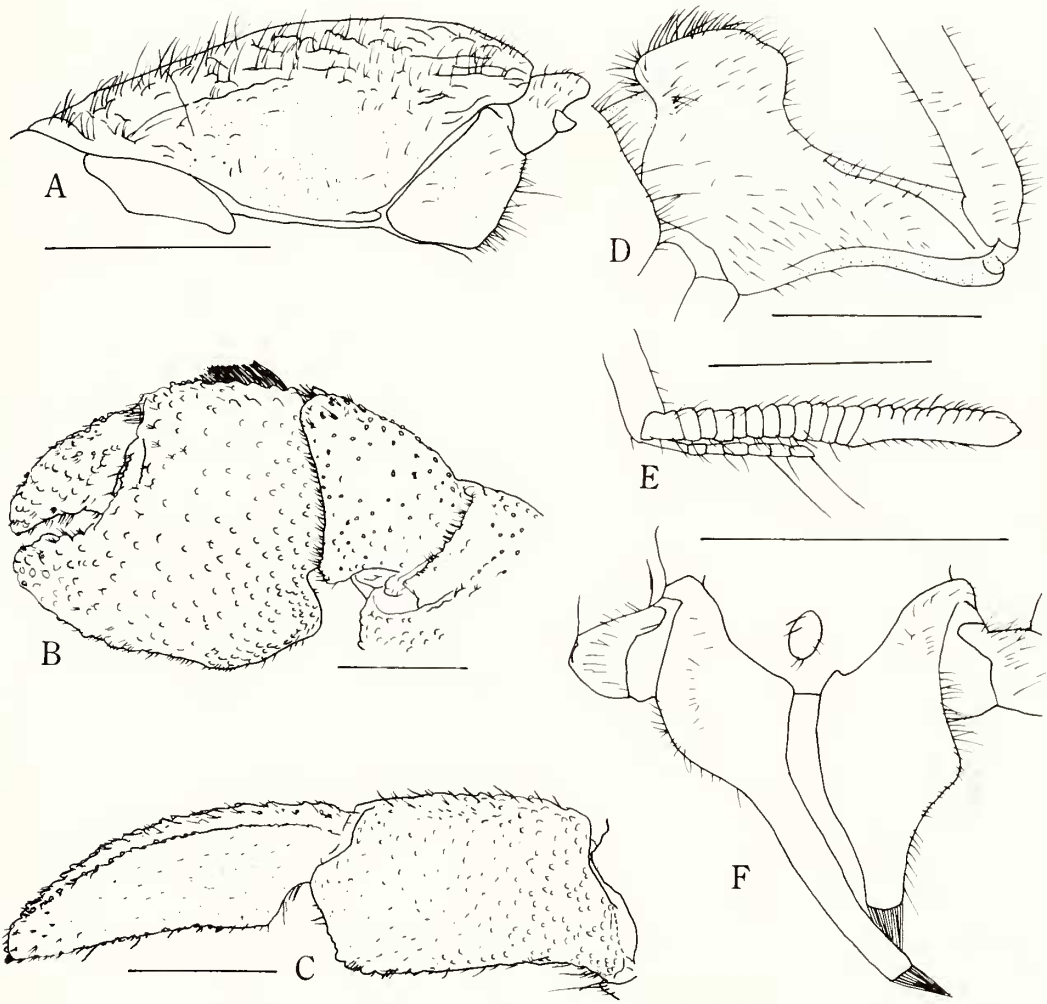

FIG. 4. *Coenobita purpureus* Stimpson, male. A, shield and antennal segments, lateral view; B, chela and carpus of left cheliped; C, left third leg; D, basal segment of antennule; E, flagella of antennule; F, sternite and coxae of male fifth legs. Scales 10 mm for A–C and F, 5 mm for D and E.

Description: Shield narrower anteriorly, strongly swollen just behind front; dorsal surface with numerous scattered granules on anterior, posterior and lateral portions; lateral margins of shield with setae.

Ocular peduncle compressed and reaching nearly to median part of ultimate segment of antennal peduncle.

Small flagellum of antennule reaching nearly to median part of large one. Antennal acicle fused with second segment of its peduncle.

Palm of left cheliped with an oblique series of up-standing four to five laminar teeth on upper part of outer surface; upper portion of palm with numerous scattered granules other than oblique teeth on outer surface, but lower portion with small granules and nearly smooth; both fingers with scattered granules on outer surface.

In left third leg outer surfaces of dactylus and propodus smooth, separated from dorsal surfaces by a well-marked longitudinal crest; outer surface of propodus not flat, but slightly swollen in midline.

In male coxae of fifth legs of both sides produced ventrally, unequal and right coxa produced into an elongate tube, usually longer than left one; its tube turning to the left and curved ventrally.

Coloration: Small individuals generally of cream color and large ones of purple color.

Distribution: In Japan this species is recorded from Chichijima, Hahajima, Anijima, Hirajima, Mukaijima and Kitaiwojima Islands in the Bonin Islands [19], the Ohsumi Peninsula and Biro I. in southern Kyushu, Tanegajima, Yakujima, Nakanojima and Takarajima Islands in the Tokara Islands, Amami-Ohshima, Kakeromajima, Kikaijima, Tokunoshima, Okinoerabujima and Yoronjima Islands in the Amami Islands [20], and from many islands in the Ryukyu Islands [17, 18, 21].

Remarks: The present species has been treated as the synonym of *C. perlatus* H. Milne Edwards by some authors since Henderson [25]. However, Bouvier [24] recognized this species as a variety of *C. perlatus,* but Terao [11] treated it as the synonym of *C. rugosus.* Miyake [7] resurrected *C. purpureus* from *C. perlatus* in the key to the Japanese species of *Coenobita,* but he did not give the colored illustration of the species. This species is easily separated from *C. perlatus* by the coloration, the shape of the palm of the large chela, the shape of dactylus and propodus of the left third leg, and by the shorter right sexual tube. This species grows to a large size as in *C. perlatus*.

This species is very abundant in the Amami and the Okinawa Islands [17, 20, 21], but it is not so abundant in the southern Ryukyus [18]. I have treated and observed a great number of specimens during the ecological investigations of the present species [21]. *C. purpureus* is without doubt a valid species.

Coenobita perlatus H. Milne Edwards (Figs. 5A–F and 9C)

Coenobita perlata H. Milne Edwards [2], p. 242.
Coenobita perlata: Fize and Serène [10], p. 24, fig. 3C, fig. 4; Yaldwyn and Wodzicki [13], p. 12.
Coenobita perlatus: Alcock [9], p. 145, pl. 14, fig. 2, 2a; Miyake [7], p. 115, pl. 39, fig. 2; Haig [16], p. 124.

Material examined: Male (SL=24.74 mm), Kitaiwojima I., the Bonin Islands, Aug. 1986, Kimura Johnson leg.

Distribution: Widely distributed in the Indo-West Pacific region. In Japan this species is known from Chichijima, Kitaiwojima and Minamitorishima Islands in the Bonin Islands [19] and from Kuroshima Island in the Yaeyama Islands [7].

Remarks: This species was first reported from Japan by Miyake [7]. His specimen was a single male and collected from Kuroshima Island by Dr. Imafuku in 1979 (Miyake, pers. commun.), but the specimens of this species were not collected since 1979. I had an opportunity to examine a male specimen from Kitaiwojima Island. According to Yaldwyn and Wodzicki [13], the juvenile specimen of 8 mm in the carapace length is creamy-white in general color and had red bands on the carpi of the chelipeds and walking legs, but the juvenile specimens of the same size of *C. purpureus* have no red bands. The question is whether *C. perlatus* reported by De Haan [26] from Kagoshima (=Satsuma) and Ryukyu is a genuine *perlatus* species, because *C. perlatus* had never been found anywhere in Kagoshima and Okinawa Prefectures after 1979 [17, 18, 20].

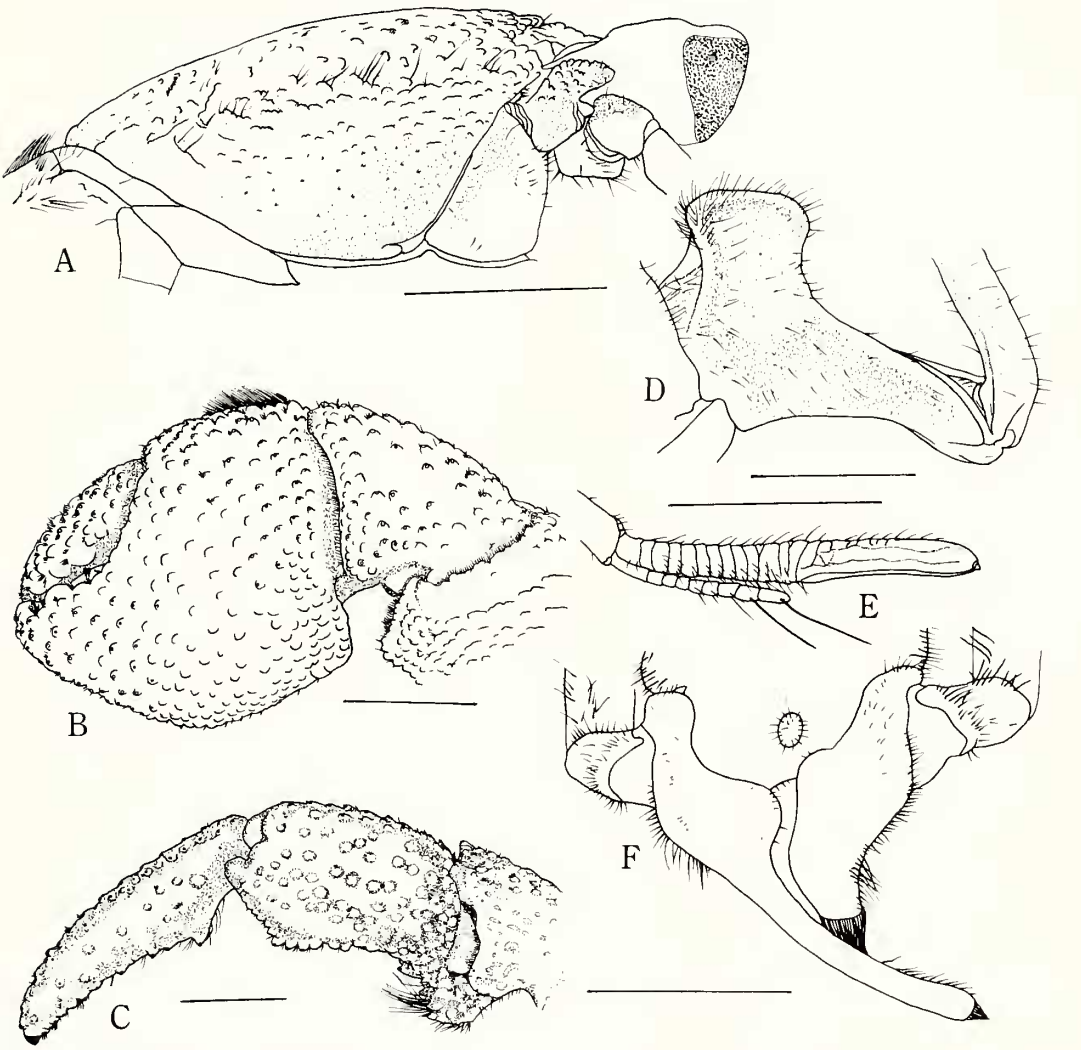

FIG. 5. *Coenobita perlatus* H. Milne Edwards, male. A, shield and antennal segments, lateral view; B, chela and carpus of left cheliped; C, left third leg; D, basal segment of antennule; E, flagella of antennule; F, sternite and coxae of male fifth legs. Scales 10 mm for A–D and F, 5 mm for E.

Coenobita cavipes Stimpson
(Figs. 6A–F and 9D)

Coenobita cavipes Stimpson [4], p. 245; Stimpson [23], p. 200.

Coenobita cavipes: Alcock [9], p. 146, pl. 14, fig. 1; Fize and Serène [10], p. 30, fig. 3B, fig. 5A–C, pl. I, 4, 6.

Material examined: I have examined a number of individuals during the ecological studies of this species.

Distribution: Widely distributed in the Indo-West Pacific region. In Japan this species is known from Chichijima and Anijima Islands in the Bonin Islands [19], Okinoerabujima and Yoronjima Islands in the Amami Islands [20] and from many islands in the Ryukyu Islands except Akajima, Ikemajima and Nanbokudaitojima Islands [17, 18].

Remarks: This species has been confused with *C. violascens* Heller by some authors. The type locality was Loo Choo (Ryukyu) [4] and Bouvier

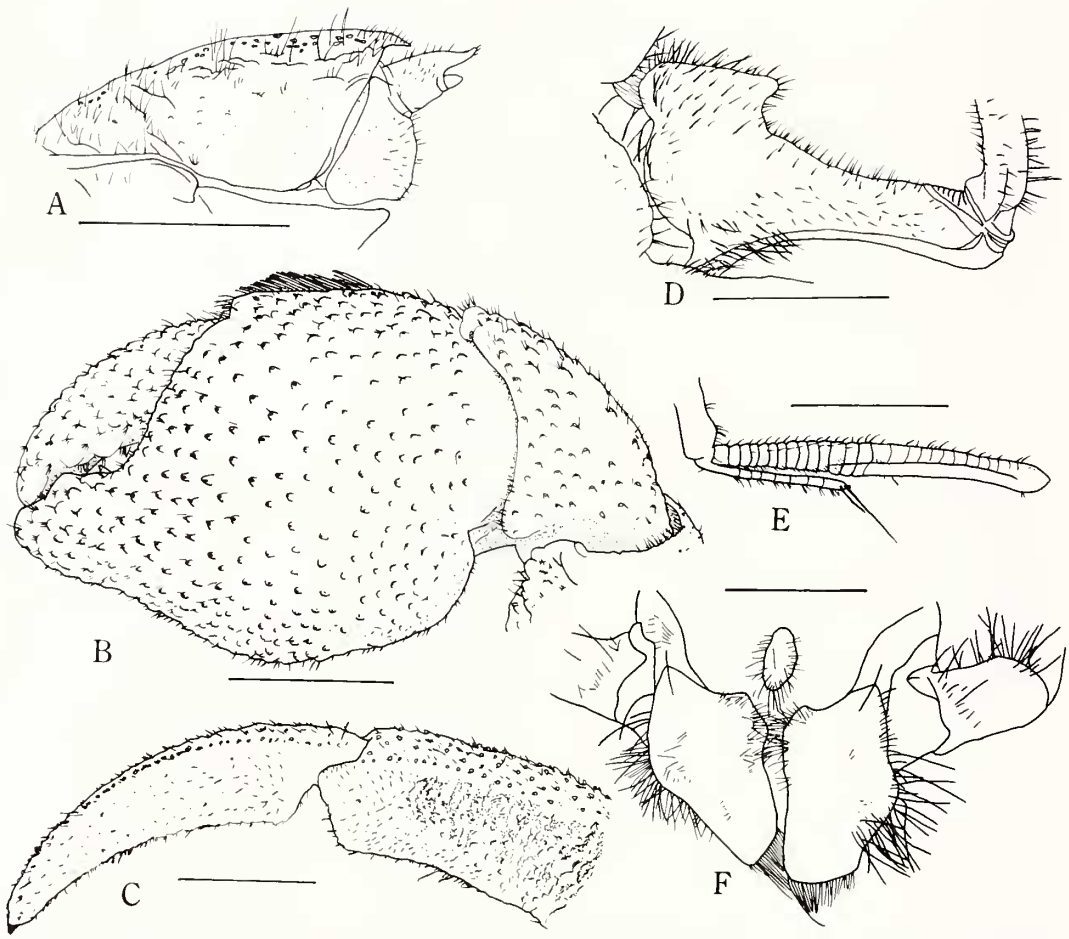

FIG. 6. *Coenobita cavipes* Stimpson, male. A, shield and antennal segments, lateral view; B, chela and carpus of left cheliped; C, left third leg; D, basal segment of antennule; E, flagella of antennule; F, sternite and coxae of male fifth legs. Scales 10 mm for A-C, 5 mm for D-F.

[24] and Fize and Serène [10] gave one locality name "Chine" in the distribution. This name "Chine" is a dialect and is now called "Kin", which is located in the central part of Okinawa mainland.

Coenobita violascens Heller
(Figs. 7A–F and 9E)

Coenobita violascens Heller [6], p. 524; Heller [27], p. 82, pl. 7, fig. 1.

Material examined: Two males (SL=4.16, 19.66 mm), 3 females (SL=6.81–16.09 mm), Hosozaki, Kohamajima I., the Yaeyama Islands, Aug. 4, 1986, K. Shimamura leg.; female (SL=17.38 mm), Ikemajima I., the Miyako Islands, Sept. 12, 1986, M. Toyama leg.; male (SL=14.02 mm), 4 females (SL=14.19–19.14 mm), estuary of Shiira river, Iriomotejima I., the Yaeyama Islands, Jan. 16, 1987, Y. Nakasone leg.; male (SL=13.43 mm), 3 females (SL=9.51–14.11 mm), Cebu I., the Philippines, Apr. 30, 1986, T. Higa leg.

Description: Shield narrower anteriorly and slightly convex behind front; dorsal surface with scattered granules and punctations; tip of antero-lateral margin of shield produced into a spinule which is white in the distal half.

Ocular acicle long and pointed. Ocular peduncle compressed, reaching almost to median part of ultimate segment of antennal peduncle. Small

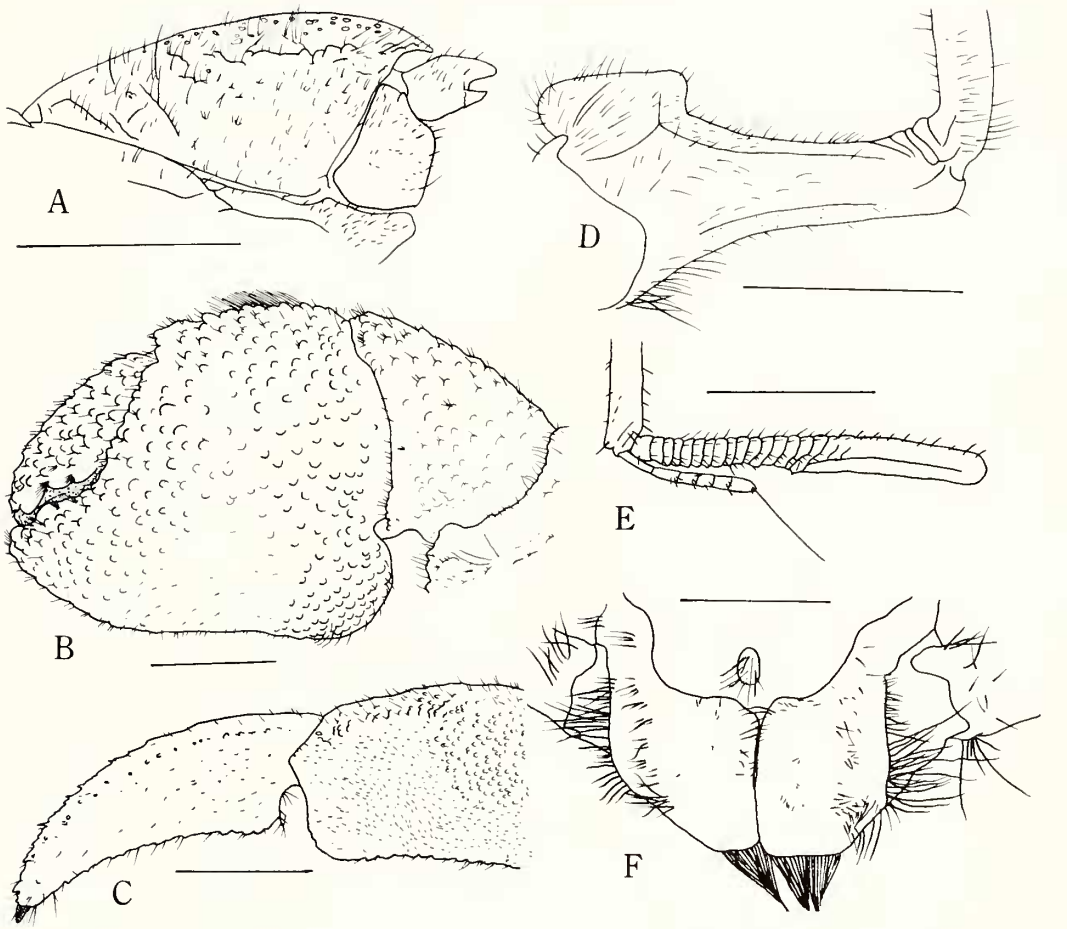

FIG. 7. *Coenobita violascens* Heller, male. A, shield and antennal segments, lateral view; B, chela and carpus of left cheliped; C, left third leg; D, basal segment of antennule; E, flagella of antennule; F, sternite and coxae of male fifth legs. Scales 10 mm for A-C, 5 mm for D–F.

flagellum of antennule small, shorter and not reaching to basal part of aesthetasc pad of large flagellum. Antennal acicle fused with second segment of its peduncle.

In left cheliped palm without an oblique series of up-standing teeth on upper part of outer surface; upper half portion of palm with numerous scattered granules, and lower half few granules, nearly smooth and with a distinct large patch of dark brown on outer surface; lower margin of palm straight or concave in middle portion and its proximal part (proximal lower margin near carpus) strongly produced into a lobe-like projection; both fingers violascent.

In left third leg outer surface of propodus nearly smooth and separated from dorsal surface by a well-marked longitudinal crest; inner margin of propodus strongly projecting inwards, and concave; a longitudinal ridge on ventral surface of propodus very small, indistinct. Second and third legs with numerous tufts of long stiff setae.

In male, coxae of fifth legs of both sides thick and short. A sternal protuberance between both coxae very small.

Coloration: Whole body except abdomen violascent, but showing light lavender to dark violet by individuals.

Distribution: Nicobar Islands; Cebu I., the

Philippines. In Japan this species is known from Ikemajima Island in the Miyako Islands and Ishigakijima, Kohamajima, Taketomijima, Iriomotejima, Yonagunijima Islands in the Yaeyama Islands [17, 18].

Remarks: This species is distinguished from *C. cavipes* by having the straight or concave lower margin of the palm of the left chela, by the violascent fingers of the left chela, by having the strongly projecting inner margin and the conspicuously concave inner surface of the left third leg propodus, by having a very small sternal protuberance between the coxae of the fifth legs of both sides, by the violascent body coloration, and by inhabiting mainly bay and estuary. In the juveniles the dactyli and propodi of the second and third legs are red brownish, and the ocular peduncle has a longitudinal dark brown stripe on the ventral surface and the other part is red brownish. Their juveniles are abundantly found near mangrove forest in Ishigakijima I., the Yaeyama Islands and they are easily distinguished from the juveniles of *C. cavipes* by the coloration of both the walking legs and the ocular peduncles and by the morphological difference of the propodus of the left third leg.

This species has been treated as the synonym of *C. compressus* and *C. cavipes* by Miers [28], De Man [5] and Fize and Serène [10], but it seems that *C. violascens* is distinctly a separate species. The specimens from the Philippines are easily distinguished from *C. cavipes*.

Coenobita brevimanus Dana
(Figs. 8A–G and 9F)

Coenobita clypeata var. *brevimanus* Dana [3], p. 473; Dana [8], pl. 30, fig. 4b.
Coenobita clypeata: Alcock [9], p. 142, pl. 15, fig. 1, la; Fize and Serène [10], p. 7, fig. 1A–C, pl. I, 1.
Coenobita hilgendorfi Terao [11], p. 338; Yu [12], p. 61, pl. 1, fig. C.
Coenobita brevimanus: Rathbun [14], p.314; Ball and Haig [15], p. 88; Haig [16], p. 124.
Coenobita brevimana: Yaldwyn and Wodzicki [13], p. 11.

Material examined: Three males (SL=15.37–18.15 mm), female (SL=15.89 mm), Ishigakijima I., the Yaeyama Islands, Dec. 4, 1985, Y. Nakasone leg. Male (SL=21.99 mm), Ishigakijima I., Sept. 11, 1986, M. Toyama leg. Two males (SL=13.58, 17.95 mm), Ikemajima I., the Miyako Islands, July 30, 1986, H. Iraha leg. Female (SL=17.07 mm), ovigerous female (SL=16.42 mm). Ikemajima I., Sept. 12, 1986, M. Toyama leg.

Distribution: Widely distributed in the Indo-West Pacific region. In Japan this species is now known from many islands in the Miyako and the Yaeyama Islands except Irabujima and Shimojijima Islands [17, 18].

Remarks: Until 1955, *Coenobita clypeatus* and *C. hilgendorfi* had been used as the scientific name of this species by many authors except some ones. Rathbun [14] used the name of *C. brevimanus* for specimens from the Indo-West Pacific for the first time.

In Japan, some individuals of this species were for the first time found within a forest near seashore in Ishigakijima Island on 4 December, 1985 and also collected from Ikemajima Island. This species is now distributed only in the southern Ryukyus. The animals were active within the forest in the daytime and they produced sound such as "Kukku, Kukku..." when they are caught. They mainly used *Turbo* (*Marmarostoma*) *argyrostomus* (Linné) as their host shell and one ovigerous female was collected in early September.

KEY TO THE SEVEN SPECIES OF *COENOBITA*

I. Antennal acicle fused with second segment of its peduncle; ocular peduncle strongly compressed; a brush of hairs on inner upper margins of palms of both chelipeds.
  A. An oblique series of up-standing laminar teeth on upper part of outer surface of left palm; right coxa of fifth legs of male narrower than left one, tubular.
    a. Outer surface of propodus of left third leg separated from dorsal surface by a well-marked longitudinal crest.
      1. Palm of left cheliped four-cornered in an external form; outer surface of propodus of left third leg flat; right coxa almost equal in length to left one, or slightly longer than

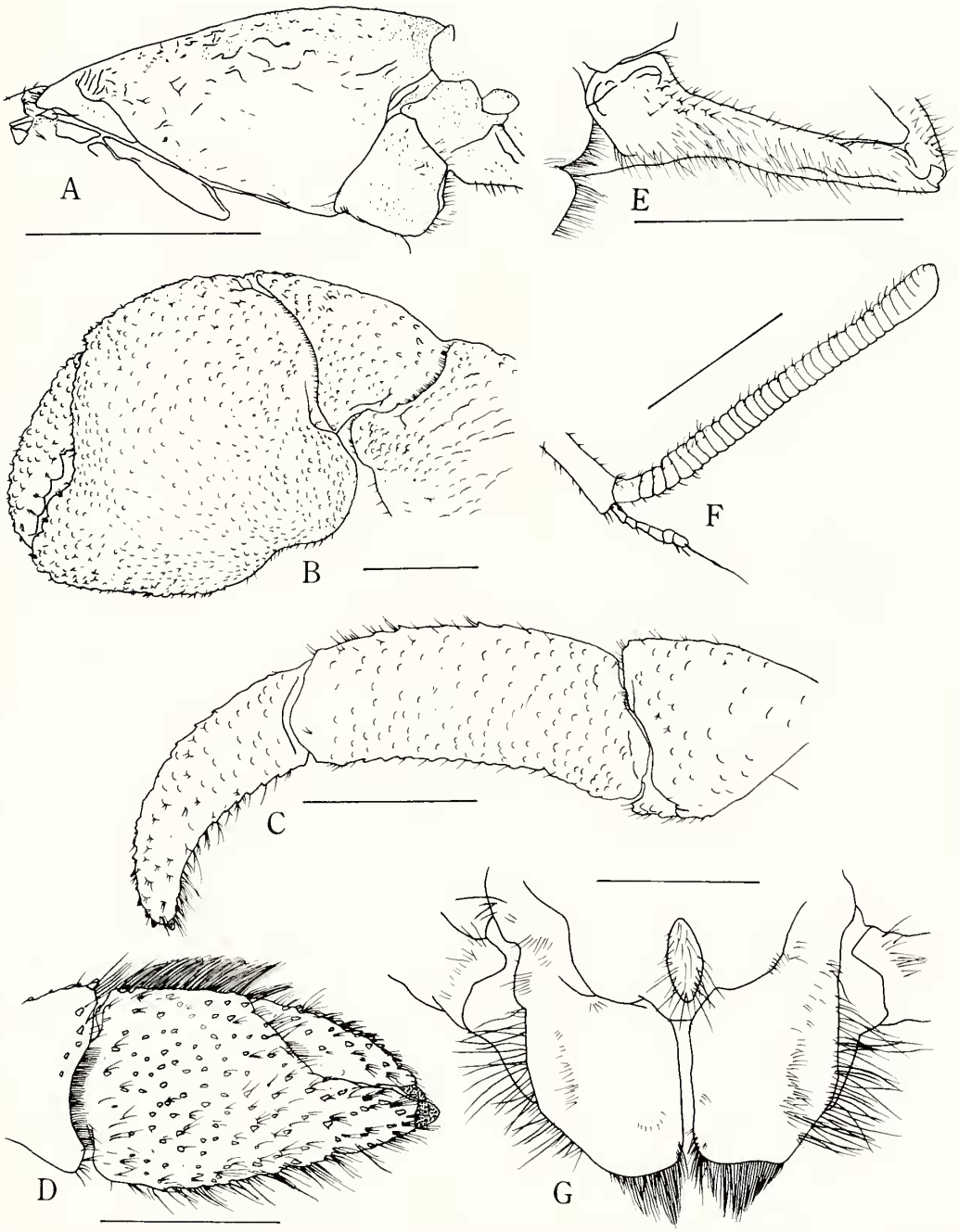

FIG. 8. *Coenobita brevimanus* Dana, male. A, shield and antennal segments, lateral view; B, chela and carpus of left cheliped; C, left third leg; D, chela of right cheliped; E, basal segment of antennule; F, flagella of antenna; G, sternite and coxae of male fifth legs. Scales 10 mm for A–E, 5 mm for F and G.

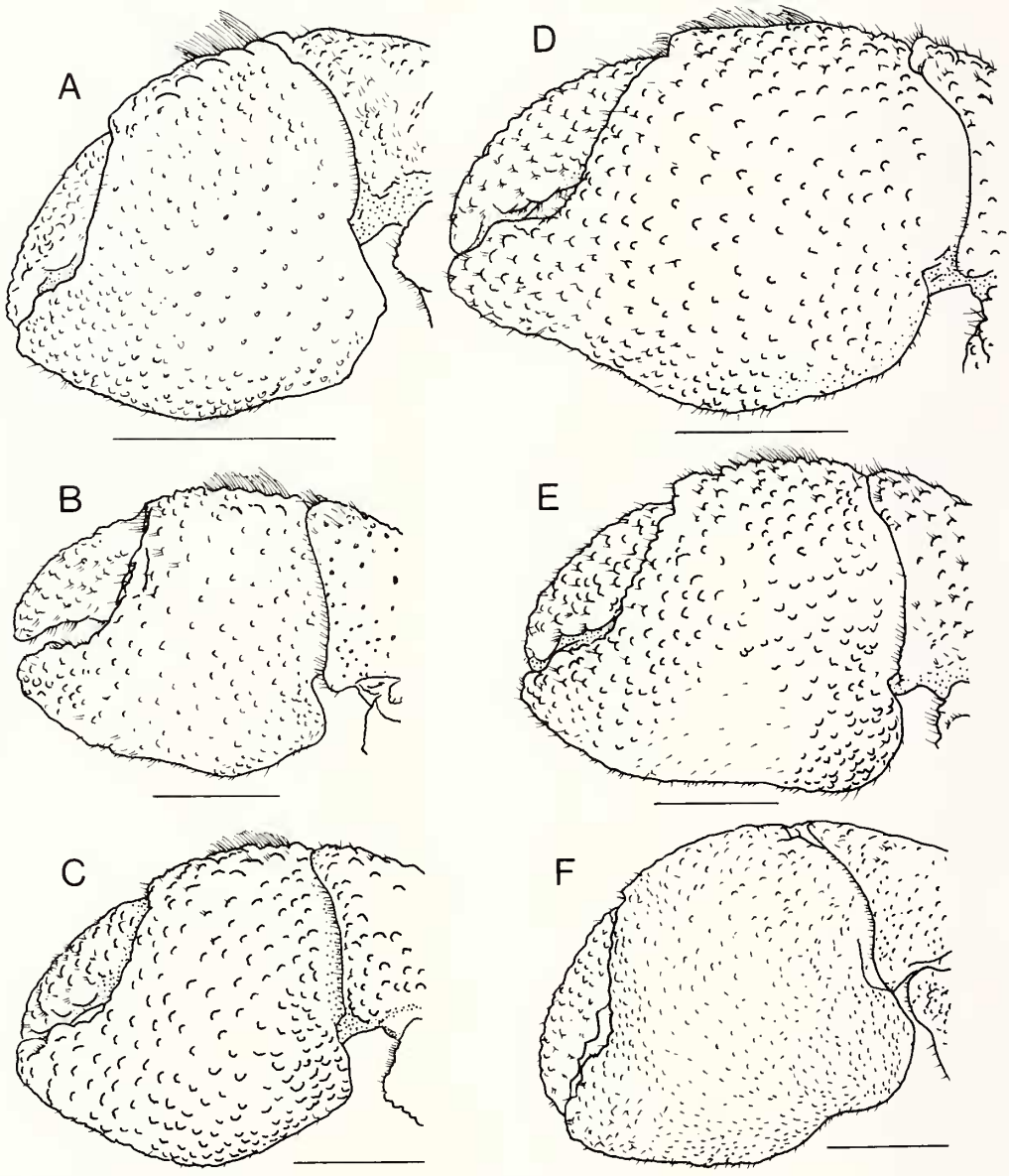

FIG. 9. Comparison of external forms of chelae. A, *Coenobita rugosus*; B, *C. purpureus*; C, *C. perlatus*; D, *C. cavipes*; E, *C. violascens*; F, *C. brevimanus*. Scales 10 mm for A–F.

left ..... *rugosus*

2. Palm of left cheliped not four-cornered in an external form; outer surface of propodus of left third leg flat; right coxa produced into an elongate tube, always longer than left one ... *pseudorugosus* n. sp.
3. Outer surface of propodus of left third leg not flat, slightly swollen in midline; coxae of fifth legs of both sides produced ventrally, unequal and right coxa produced into an elongate tube, usually longer than left one ..... *purpureus*

b. Outer surface of propodus of left third leg not separated from dorsal surface by a

longitudinal crest.

4. Outer surface of propodus of left third leg convex and with scattered white tubercles; right coxa produced into a long curved tube ..... *perlatus*

B. No oblique series of up-standing laminar teeth on upper part of outer surface of left palm; coxae of fifth legs of both sides thick and short.

5. Lower margin of left palm with an obtuse corner in middle portion; inner margin of propodus of left third leg not strongly projecting inwards and inner surface almost flat; a longitudinal ridge on ventral surface of propodus well-developed, distinct; a sternal protuberance between both coxae of fifth legs large ..... *cavipes*

6. Lower margin of left palm straight or concave in middle portion; inner margin of propodus of left third leg strongly projecting inwards and inner surface strongly concave; a longitudinal ridge on ventral surface of propodus very small, indistinct; a sternal protuberance between both coxae of fifth legs very small ..... *violascens*

II. Antennal acicle not fused with second segment of its peduncle; ocular peduncle not compressed; a brush of hairs on inner upper margin of palm of right cheliped only ..... *brevimanus*

ACKNOWLEDGMENTS

I am very grateful to Dr. S. Shokita, Department of Marine Sciences, University of the Ryukyus, Mr. M. Toyama, Cultural Administration Section, Okinawa Prefectural Office of Education, and Mr. K. Shimamura, Yaeyama Senior High School, for providing specimens for the present study. I am indebted to Dr. S. Miyake, Emeritus Professor of Kyushu University, for valuable advice and encouragement. Most of this work was made by a support of Agency for Culture Affairs, the Ministry of Education, Science and Culture of Japan.

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